

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 08 November 2000 (08.11.00)	
International application No. PCT/GB00/01164	Applicant's or agent's file reference P22384A/GMM/
International filing date (day/month/year) 27 March 2000 (27.03.00)	Priority date (day/month/year) 26 March 1999 (26.03.99)
Applicant LOXLEY, Neil et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 29 September 2000 (29.09.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
 34, chemin des Colombettes
 1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740 14 35

Authorized officer

Olivia TEFY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P22384A/GMM/	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/ 01164	International filing date (day/month/year) 27/03/2000	(Earliest) Priority Date (day/month/year) 26/03/1999
Applicant BEDE SCIENTIFIC INSTRUMENTS LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of Invention is lacking (see Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawing to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ Non of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/01164

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01J35/14 H01J35/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 631 742 A (OLIVER DAVID W) 23 December 1986 (1986-12-23) column 1, line 50 -column 2, line 37; figure 1	1
Y	column 4, line 10-34	8-11
X	US 4 748 650 A (AMMANN ERNST) 31 May 1988 (1988-05-31)	1
Y	column 1, line 15-68; figures 1,2	8-11
Y	WO 98 13853 A (ARNDT ULRICH WOLFGANG ;BEDE SCIENT INSTR LTD (GB); DUNCUMB PETER () 2 April 1998 (1998-04-02) claims 1,7,8	8-11

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *Z* document member of the same patent family

Date of the actual completion of the international search

19 July 2000

Date of mailing of the international search report

26/07/2000

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
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Authorized officer

Centmayer, F

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/01164

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 689 809 A (SOHVAL A ROBERT) 25 August 1987 (1987-08-25) abstract figures 1,2 -----	1
A	EP 0 473 852 A (IMATRON INC) 11 March 1992 (1992-03-11) column 7, line 43-51; figure 5 column 8, line 24-34 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/01164

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4631742	A	23-12-1986	NONE		
US 4748650	A	31-05-1988	DE	3401749 A	01-08-1985
			DE	3470361 D	11-05-1988
			EP	0150364 A	07-08-1985
WO 9813853	A	02-04-1998	AU	4313197 A	17-04-1998
			EP	0928496 A	14-07-1999
US 4689809	A	25-08-1987	DE	3342127 A	07-06-1984
			FR	2536583 A	25-05-1984
			IL	70210 A	20-10-1987
			IT	1178354 B	09-09-1987
			JP	1731584 C	29-01-1993
			JP	4015982 B	19-03-1992
			JP	59149642 A	27-08-1984
			NL	8304028 A, B,	18-06-1984
EP 0473852	A	11-03-1992	US	4993055 A	12-02-1991
			US	5105456 A	14-04-1992

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Murgitroyd & Company
373 Scotland Street
Glasgow G5 8QA
GRANDE BRETAGNE

MURGITROYD
& COMPANY

U 6 AUG 2001

COMP

GMM

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NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
(day/month/year)

02.08.2001

Applicant's or agent's file reference
P22384A/GMM/GMU

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/01164

International filing date (day/month/year)
27/03/2000

Priority date (day/month/year)
26/03/1999

Applicant

BEDE SCIENTIFIC INSTRUMENTS LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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Authorized officer

Schuster-Kaechele, W

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P22384A/GMM/GMU	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/01164	International filing date (day/month/year) 27/03/2000	Priority date (day/month/year) 26/03/1999
International Patent Classification (IPC) or national classification and IPC H01J35/14		
Applicant BEDE SCIENTIFIC INSTRUMENTS LIMITED et al.		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 9 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 4 sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none">I <input checked="" type="checkbox"/> Basis of the reportII <input type="checkbox"/> PriorityIII <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicabilityIV <input checked="" type="checkbox"/> Lack of unity of inventionV <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statementVI <input type="checkbox"/> Certain documents citedVII <input checked="" type="checkbox"/> Certain defects in the international applicationVIII <input checked="" type="checkbox"/> Certain observations on the international application		
Date of submission of the demand 29/09/2000	Date of completion of this report 02.08.2001	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Telephone No. +49 89 2399	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01164

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-14 as originally filed

Claims, No.:

1-13 as received on 02/03/2001 with letter of 02/03/2001

Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01164

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
☐ paid additional fees.
☐ paid additional fees under protest.
☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-4,6-10,12,13
	No:	Claims	5
Inventive step (IS)	Yes:	Claims	1-4,12
	No:	Claims	13

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01164

Industrial applicability (IA) Yes: Claims 1-13
 No: Claims

2. Citations and explanations
 see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Reference is made to the following documents:

D1: US-A-4 631 742
D2: US-A-4 748 650
D3: WO-A-98/13853
D4: JP-A-10340695
D5: US-A-5 857 008

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. D1 (see in particular the places indicated in the Search Report) describes an X-ray generator comprising a electron gun (12), electron focussing means (16), a target (18) and electronic control means (52) , wherein the area of the target on which the focussing means causes electrons from said electron gun to impinge forms an X-ray source. The control means includes a switching means to switch the electron focusing means between a first unfocused state in which the X-ray source has a first area and second focused state in which the X-ray source has a second area smaller than the first area.

D4 describes an X-ray generator comprising a shutter (7) to control the emitted X-ray beam.

The problem to be solved by the present invention may be regarded as providing means to lengthen the life of the X-ray generator by reducing the degradation of the target in periods in which the X-ray beam is not required (see page 3. lines 5-17, page 9, line 26 to page 10, line 5).

This is obtained by the X-ray generator according to claim 1 and the method according to claim 11 in that the shutter is closed when the X-ray beam is not required and, at the same time, the electron beam is defocused such that the area

on the target which forms the X-ray source is large. This way the heat load on the target, when the X-ray beam is not required, is reduced.

D1 teaches the defocusing of the electron beam on start-up of an X-ray generator until the target has reached the desired temperature. It does not concern a stand-by operation when the X-ray beam is not required.

The solution to the problem proposed in claims 1 and 11 of the present application is considered new (as Article 33(2) PCT) and involving an inventive step (Article 33(3) PCT) because it is not known from any of the documents cited in the Search Report nor is it suggested by these documents.

2. Claims 2-4, 6-10 and 12 are dependent on claims 1 or 11 and as such also meet the requirements of the PCT with respect to novelty and inventive step.
3. D2 (see in particular the places indicated in the Search Report) describes an X-ray generator comprising a electron gun (1), electron focussing means (3), a target (2) and electronic control means (9,11), wherein the area of the target on which the focussing means causes electrons from said electron gun to impinge forms an X-ray source. The control means are adapted to control deflection means so that the X-ray source on said target may be varied in shape and/or size. The control means includes a switching means (see in particular figure 4) to switch between a plurality of states, the X-ray source having a particular size and/or position (see col. 2, lines 47-62). It is proposed in D2 to vary the size/position in stages. For a certain period of time thereby the X-ray source is in a stationary position (see fig. 2).
Therefore, the X-ray generator according to claim 5 is not new (Art. 33 (2) PCT).

4. Dependent claims 6-10 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:
The skilled person can choose appropriate sizes of the source areas within his normal non-inventive activity.
x-y deflection systems for centring the electron beam and electron lenses are well known in combination with X-ray tubes.
Quadrupole or multipole electron lenses for focussing the electron beam to a line

focus and for steering the electron beam are known from D3.

The materials stated in claim 10 are normal target materials for X-ray tubes and e.g also mentioned in D3.

5. The concept of using a fresh area of the target when one area has degraded is known from D5 (see in particular col. 3, line 45 to col. 4, line 4 and figure 1). For each area, the position of the electron beam on the target is stationary. It is evident for a person skilled in the art the areas should not overlap and that a particular position of the electron beam on the target can be obtained by moving either the target or the electron beam.

The skilled person would therefore regard it a normal design procedure to combine features known from D2 with features known from D5.

Thus, the subject-matter of claim 13 does not involve an inventive step and does not satisfy the criterion set forth in Article 33(3) PCT.

Re Item VII

Certain defects in the international application

1. The description has not been brought in line with the amended claims. The more general statements in the description on page 9, line 26 to page 10, line 5 and page 11, line 22 to page 12, line 5 imply that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).
2. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1, D2, D4 and D5 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Re Item IV

Lack of unity of invention

The separate inventions/groups of invention are:

1. Claims 1-4, 11, 12 and 6-10 as dependent on claim 1
2. Claims 5, 13 and 6-10 as dependent on claim 5

With regard to D2, the "special technical features" of claims 1 and 11 are:
a shutter and defocusing of the electron beam upon action of this shutter.

Claims 5 does not include any "special technical features" (see item V, point 3).

The features of claims 6-10 as dependent on claim 5 do not have anything in common with the "special technical features" of claims 1 and 11.

"Special technical feature" of claim 13 is : no overlap between discrete positions.

This "special technical feature" is also different from the "special technical features" of claims 1 and 11.

The requisite unity of invention (Rule 13.1 PCT) therefore does not exist inasmuch as a technical relationship involving one or more of the same or corresponding special technical features in the sense of Rule 13.2 PCT does not exist between the subject-matter of groups 1 and 2.

Observation as to the disclosure of the subject-matter of amended claims

Claims 1 and 11 correspond to claims 1 and 2 or 12 and 13 as originally filed, with the addition of the feature that the electron beam is defocused upon activation of the shutter, which has a basis at page 9, line 34 to page 10, line 5.

Claims 5 and 13 correspond to claims 1 and 6 or 14 as originally filed, with the addition

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/01164

of the feature that the corresponding discrete position of the target is stationary, the basis for this feature can be found at page 11, line 22 to page 12, line 5 of the application as filed.

Claims 2 to 4 correspond to original claims 3 to 5 and claims 6 to 10 correspond to original claims 7-11.



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H01J 35/14, 35/30	A1	(11) International Publication Number: WO 00/58991 (43) International Publication Date: 5 October 2000 (05.10.00)
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(21) International Application Number: PCT/GB00/01164

(22) International Filing Date: 27 March 2000 (27.03.00)

(30) Priority Data:
9906886.8 26 March 1999 (26.03.99) GB

(71) Applicant (for all designated States except US): BEDE SCIENTIFIC INSTRUMENTS LIMITED [GB/GB]; Bowburn South Industrial Estate, Bowburn, Durham DH6 5AD (GB).

(72) Inventors; and

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(74) Agent: MURGITROYD & COMPANY; 373 Scotland Street, Glasgow G5 8QA (GB).

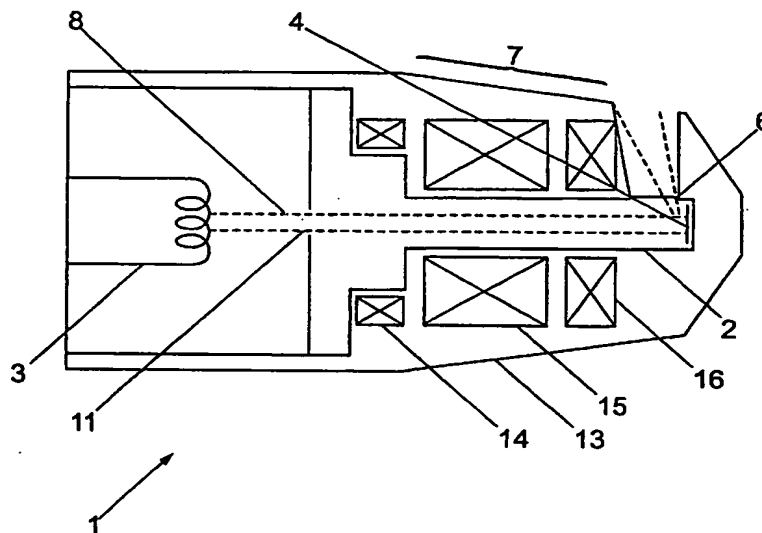
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS FOR PROLONGING THE LIFE OF AN X-RAY TARGET



(57) Abstract

An X-ray generator (1) comprises an evacuated and sealed X-ray tube (2), containing an electron gun (3) and an X-ray target (4). An electron beam is produced by the electron gun (3) in which the cathode is at negative high voltage, the electron gun (3) consisting of a filament just inside the aperture (11) of a Wehnelt grid which is biased negatively with respect to the filament. Two sets of beam deflection coils (14), are employed in two planes, mounted between the anode of the electron gun (3) and the focussing lens (15) to centre the beam. Between the focussing lens (15) and the target (4) is an air-cored quadrupole magnet which acts as a stigmator (16) in that it turns the circular cross-section of the beam into an elongated one. This quadrupole (16) can be rotated about the tube axis so as to adjust the orientation of the line focus. The beam can be moved about the target surface (4) by controlling the currents in the four coils of the quadrupole (16).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
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EE	Estonia						

3/pats

09/937609

PCT/GB00/01164

JC09 Rec'd PCT/PTO 26 SEP 2001

1 ~~Method and Apparatus for Prolonging the Life of an~~
2 ~~X-Ray Target~~
3

4 This invention relates to an X-ray generator, and in
5 particular to apparatus for prolonging the life of an
6 X-ray target used within an X-ray generator.
7

8 Known X-ray generators comprise an electron gun, an X-
9 ray target and an X-ray exit window. These generators
10 produce X-rays by accelerating electrons from the
11 electron gun into the x-ray target. X-rays are emitted
12 from the target through the exit window. Such
13 generators may be in the form of sealed X-ray tubes,
14 for example microfocus tubes, which are evacuated once
15 and then sealed off, or in the form of rotating anode
16 generators, which are permanently connected to vacuum
17 pumps and are continuously evacuated during operation.
18

19 A major limitation to the longevity of X-ray generators
20 is the lifetime of the target. All targets degrade
21 over time due to the effects of heat and roughening
22 caused by the electron bombardment. There are various
23 known methods for reducing these effects, including
24 cooling the back of the target with flowing water or
25 rotating the target so that no one area of the target
26 is continuously subjected to the electron bombardment.

1 Methods of increasing the cooling efficiency have been
2 proposed based on using high conductivity materials
3 such as diamonds. However, these methods are not in
4 common usage currently.

5
6 With known X-ray generators, it can take a number of
7 minutes after switching on the machine before it has
8 stabilised and is ready for use. As a result, many
9 generators are simply left running throughout the day,
10 so that the "warm-up" or stabilisation delay is
11 removed. This means that the electrons are focussed on
12 the target for long periods of time during each use of
13 the generator, which leads to accelerated degradation
14 of the target, even though the radiation produced by
15 the X-ray generator is used only for short periods.

16
17 In cases where the construction of the generator
18 permits, the target can be replaced. Where the
19 construction does not permit target replacement in a
20 routine procedure, then it is common practice to
21 discard the complete tube assembly making up the X-ray
22 generator.

23
24 In commercially available sealed tube and rotating
25 anode generators, there is no provision to control the
26 position of the beam on the target or to control the
27 quality, size or shape of the focal spot on the X-ray
28 target. The quality of the X-ray beam emitted can
29 deteriorate rapidly with prolonged use due to
30 contamination and damage to the target area under
31 continuous electron bombardment.

32
33 In the case of rotating anode generators, once
34 performance has degraded below a useful level,
35 replacement of the target is required. This entails
36 cost of replacement parts as well as significant down

1 time of the generator. In the case of sealed tube
2 generators it is necessary to discard the whole tube and
3 replace it with a new tube.

4
5 It is an object of the present invention to provide
6 means to lengthen the life of a target, and thereby to
7 lengthen the life of the X-ray generator. By
8 controlling the position and brightness of the beam,
9 the apparatus according to the present invention can
10 reposition and modify the area of focus of the beam.
11 Defocussing the beam reduces the flux per unit area of
12 electrons on the target. Repositioning the beam
13 enables a fresh area of the target to be exposed to
14 electrons. The lifespan of the target is prolonged by
15 either of these means, and the time interval between
16 replacements of the target or of the complete tube
17 assembly is increased.

18
19 A consequence of the approach of the present invention
20 is that the tube is only required to run in operational
21 condition with the target exposed to focussed electrons
22 when the operator requires the X-ray beam to be
23 produced.

24
25 According to the present invention, there is provided
26 an X-ray generator comprising an electron gun, electron
27 focussing means, a target and electronic control means,
28 wherein the area of the target on which the focussing
29 means causes electrons from said electron gun to
30 impinge comprises an X-ray source, the control means
31 being adapted to control the electron focussing means
32 so that the X-ray source on said target may be varied
33 in size and/or shape and/or position.

34
35 According to a first aspect of the invention the
36 control means includes a switching means to switch the

1 electron focussing means between a first unfocussed
2 state in which the X-ray source has a first area and a
3 second focussed state in which the X-ray source has a
4 second area smaller than said first area. The second
5 area may be a line, a spot or some other profile. The
6 first area may be a line of greater thickness, a spot
7 of greater diameter or some other shape.

8
9 Preferably said first area has a surface area at least
10 twice, more preferably four times, most preferably ten
11 times that of said second area.

12
13 According to a second aspect of the invention the
14 control means includes a switching means to switch the
15 electron focussing means between a plurality of
16 focussed states, whereby in each state the X-ray source
17 is in a corresponding discrete position on said target.
18 The X-ray source may be in the form of a line, a spot
19 or some other profile on the target.

20
21 The electron gun may comprise an evacuated tube around
22 which the electron focussing means is mounted outside
23 the vacuum. Alternatively the electron gun may
24 comprise an evacuated tube within which the electron
25 focussing means is mounted. The evacuated tube may be
26 a sealed vacuum tube or may be connected to a vacuum
27 pump which permits continuous evacuation during
28 operation of the generator.

29
30 The electron focussing means may comprise an x-y
31 deflection system for centring the electron beam in the
32 tube. The electron beam focussing means may further
33 comprise at least one electron lens, preferably an
34 axially symmetric or round lens, and/or at least one
35 quadrupole or multipole lens for focussing the electron
36 beam to a line focus and for steering the electron

1 beam.

2

3 The electron beam lenses may be magnetic or
4 electrostatic.

5

6 Preferably the target is metal, most preferably a metal
7 selected from the group Cu, Ag, Mo, Rh, Al, Ti, Cr, Co,
8 Fe, W, Au. The target surface may be orientated such
9 that the plane of the target surface is perpendicular
10 or at an angle to the axis of the X-ray tube.

11

12 According to a third aspect of the present invention
13 there is also provided a method for extending the life
14 of a target of an X-ray generator, wherein the
15 generator comprises an electron gun, electron focussing
16 means and a target, the method comprising the steps of:
17 firing electrons at the target such that the area of
18 the target on which the focussing means causes
19 electrons from said electron gun to impinge comprises
20 an X-ray source,
21 controlling the electron focussing means to move
22 between a first unfocussed state in which the X-ray
23 source has a first area and a second focussed state in
24 which the X-ray source has a second area smaller than
25 said first area, the intensity of electron impingement
26 in the first state being sufficiently low to reduce
27 target degradation, the intensity of electron
28 impingement in the second state being sufficiently high
29 such that the source produces a predetermined required
30 level of brightness and source size on the target. The
31 source may be a spot, a line or some other profile.

32

33 Preferably the electron beam current is substantially
34 the same in the first and second states, while the
35 intensity of the beam per unit area at the target is
36 lower in the first state than in the second state.

1 According to a fourth aspect of the present invention
2 there is provided a method for extending the life of a
3 target of an X-ray generator, wherein the generator
4 comprises an electron gun, electron focussing means and
5 a target, the method comprising the steps of:
6 firing electrons at the target such that the area of
7 the target on which the focussing means causes
8 electrons from said electron gun to impinge comprises
9 an X-ray source,
10 controlling the electron focussing means to move
11 between a plurality of focussed states, whereby in
12 each state the X-ray source is in a corresponding
13 discrete position on said target, such that the
14 intensity per unit area in each discrete position is
15 substantially constant, and such that there is no
16 overlap on the target between the discrete positions
17 corresponding to each focussed state. The source may
18 be a spot, a line or some other profile.

19
20 The lack of overlap between the discrete positions on
21 the target means that a fresh area of target is used as
22 a source each time the electron focussing means moves
23 to a new state. The control of the electron focussing
24 means may be manual but is preferably electronic, so
25 that each discrete position corresponds to a pre-
26 programmed control signal applied to the electron
27 focussing means.

28
29 An embodiment of the invention will now be described,
30 by way of example only, with reference to the
31 accompanying figures, where:

32
33 Fig. 1 shows a schematic longitudinal section through
34 an X-ray generator according to the invention suitable
35 for use with a close coupled X-ray focussing system
36 (not shown);

1

2 Fig. 2 shows a schematic arrangement of an X-ray
3 generator in the focussed state;

4

5 Fig. 3 shows a schematic arrangement of an X-ray
6 generator in the defocussed state;

7

8 Fig. 4 shows a schematic arrangement of an X-ray
9 generator with the target in a first focussed position;

10

11 Fig. 5 shows a schematic arrangement of an X-ray
12 generator with the target in a second focussed
13 position;

14

15 Figs. 6(a) and 6(b) shows schematically a side view and
16 plan view respectively on a sealed tube X-ray generator
17 according to the invention; and

18

19 Figs. 7(a) and 7(b) shows schematically a side view and
20 front view respectively on a rotating anode X-ray
21 generator according to the invention.

22

23 With reference to Fig. 1, the X-ray generator 1
24 comprises an evacuated and sealed X-ray tube 2,
25 containing an electron gun 3 and an X-ray target 4.
26 The tube 2 has an exit window 6 through which X-rays
27 are emitted from the target. Although the embodiment
28 illustrated in Fig. 1 has a window 6 in front of the
29 target 4, it is to be understood that the invention is
30 applicable to other embodiments, for example X-ray
31 generators in which the X-rays are emitted behind the
32 target 4. The exit window does not form part of the
33 invention and is not further described.

34

35 The tube 2 is contained within a housing 13. The
36 generator 1 also includes a system 7 for focussing and

1 steering the electron beam 8 onto the target 4.

2

3 The focussing and steering system is capable of
4 producing a well focussed beam of electrons 8 impinging
5 on the target 4. The electron beam 8 may be focussed
6 into a spot or a line, and the dimensions of the spot
7 and line as well as its position may be changed
8 electronically. In typical X-ray applications a spot
9 focus having a diameter falling in the range 1 to 100
10 μm , generally 5 μm or larger, may be required.

11 Alternatively a line focus may be achieved whose width
12 falls in the range 0.4 mm to 1.0 mm, and length in the
13 range 5 mm to 15 mm.

14

15 The electron beam 8 is produced by an electron gun 3
16 consisting of a Wehnelt electrode and cathode. The
17 cathode may be a filament of tungsten or alloy, for
18 example tungsten-rhenium, having either a hairpin or a
19 staple shape. Alternatively the cathode may be an
20 indirectly heated activated dispenser cathode, which
21 may be flat or of other geometry, for example a rod
22 with a domed end. The dispenser cathode has the
23 advantage of extended lifetime and increased mechanical
24 strength. With a flat surface the dispenser cathode
25 has the further advantage of requiring only an
26 approximate degree of alignment in the Wehnelt
27 electrode.

28

29 Primary focus is achieved by an anode at a suitable
30 distance from the electron gun.

31

32 The electron beam 8 from the gun is centred in the X-
33 ray tube 2 by a centring coil 14 or set of quadrupole
34 lenses. Alternatively it may be centred by multipole
35 lenses. Alternatively mechanical means may be used to
36 centre the electron beam 8. The centring lens or coil

1 14 may be omitted, where the electron gun 3 is such
2 that it produced an electron beam 8 which is
3 sufficiently aligned within the tube 2.
4

5 The electron beam 8 is then focussed to a spot of
6 varying diameter. Focussing down to a diameter of less
7 than 5 μm or better may be achieved by an axial
8 focussing lens 15 of the quadrupole, multipole or
9 solenoid type.
10

11 The spot focus may be changed to a line focus with a
12 stigmator lens 16, which may comprise a further set of
13 quadrupole or multipole lenses. Lines with an aspect
14 ratio of greater than 10:1 are possible. A line focus
15 spreads the load on the target. When viewed at a
16 suitable angle, the line appears as a spot.
17

18 The lenses 15, 16 are preferably magnetic, but may be
19 electrostatic. All the lenses are electronically
20 controlled, enabling remote control and continuous
21 alignment and scanning of the focal spot. Change from
22 spot to line focus and change of beam diameter are also
23 controlled remotely by varying the control signals to
24 the electron focussing devices 7.
25

26 The electronic control of the lenses enables the
27 electron beam 8 to be defocussed and/or repositioned on
28 the target 4. As a result, the high intensity focal
29 spot of the electron beam 8 is not continuously being
30 directed at one particular area of the target 4, which
31 means that the rate of degradation of the target will
32 be significantly slower than with known X-ray
33 generators. The electron beam 8 is only focussed at
34 high intensity when the X-ray beam is required.
35

36 The actions of defocussing and refocussing the electron

1 beam 8 are activated either at will by the operator by
2 varying the power of the focussing coils, preferably by
3 an electronic switch control, or automatically by the
4 action of a shutter on the output side of the X-ray
5 beam or other external event defined by the operator.

6
7 The target 4 is a metal, for example Cu, but it can be
8 another material depending on the wavelength of the
9 characteristic radiation required, for example Ag, Mo,
10 Al, Ti, Rh, Cr, Co, Fe, W or Au. The target 4 is
11 either perpendicular to the impinging electron beam 8,
12 or may be inclined to decrease the absorption of the
13 emitted X-rays.

14
15 In an example of a preferred embodiment of the present
16 invention, the cathode is at negative high voltage and
17 the electron gun 3 consists of a filament just inside
18 the aperture 11 of a Wehnelt grid which is biased
19 negatively with respect to the filament. The electrons
20 are accelerated towards the anode which is at ground
21 potential and pass through a hole in the latter and
22 then through the tube 2 towards the target 4. Two sets
23 of beam deflection coils 14, which may be iron-cored,
24 are employed in two planes separated by 30 mm, mounted
25 between the anode of the electron gun 3 and the
26 focussing lens 15 to centre the beam. Between the
27 focussing lens 15 and the target 4 is an air-cored
28 quadrupole magnet which acts as a stigmator 16 in that
29 it turns the circular cross-section of the beam 8 into
30 an elongated one. This quadrupole 16 can be rotated
31 about the tube axis so as to adjust the orientation of
32 the line focus. The beam 8 can be moved about on the
33 target surface 4 by controlling the currents in the
34 four coils of the quadrupole 16.

35
36 With reference to Figs. 2 and 3 there is shown a tube

1 2, electron gun 3 and target 4, together with electron
2 focussing means 7, which are discussed in more detail
3 above. In the first focussed state, as shown in Fig.
4 2, the electron beam 8 is focussed by the focussing
5 means 7 so that it forms a relatively small spot 20 on
6 the target 4, the spot source being the required size
7 for generation of X-rays for the intended purpose. In
8 this state the X-ray generator is operational and the
9 brightness of the emitted X-ray beam may be controlled
10 by varying the applied power to the tube. When the
11 generator is switched to the second unfocussed state as
12 shown in Fig. 3, the electron beam 18 has the same
13 power, but the focussing means does not focus the beam
14 18 so tightly, so that it forms a relatively larger
15 spot source 21 on the target 4. In this state the X-
16 ray generator is in standby mode and the intensity per
17 unit area at the target 4 is greatly reduced. The
18 consequent localised degradation of the target, which
19 depends on local intensity per unit area, is also
20 reduced.

21
22 With reference to Figs. 4 and 5 there is shown a tube
23 2, electron gun 3 and target 4, together with electron
24 focussing means 7, which are discussed in more detail
25 above. In the first focussed state, as shown in Fig.
26 4, the electron beam 28 is focussed by the focussing
27 means 7 so that it forms a relatively small spot source
28 22 on the target 4, the spot source being the required
29 size for generation of X-rays for the intended purpose.
30 In this state the X-ray generator is operational and
31 the brightness of the emitted X-ray beam may be
32 controlled by varying the applied power to the tube.
33 When the generator is switched to a second focussed
34 state, as shown in Fig. 5, the electron beam 38 has the
35 same power, but is focussed by the focussing means to a
36 second spot source 23 on a different part of the target

1 4. The spot source 23 is the required size for
2 generation of X-rays for the intended purpose, and will
3 generally be the same size as the spot source 22 in the
4 first state. There is no overlap between the positions
5 of spot sources 22 and 23.

6
7 In practice there may be further operational states in
8 which the spot source is the same size as spot sources
9 22, 23 but in different, non-overlapping locations. It
10 may be possible to fit as many as ten or more non-
11 overlapping sources on a target, thus giving a ten-fold
12 increase in the life of the target. The focussing
13 means 7 may be adjusted manually to move the spot
14 source, or the control signals required to adjust the
15 focussing means may be stored electronically, so that
16 the apparatus automatically steps to the next state
17 when an operator indicates that the position of the
18 focus should be changed. The stepping could be
19 automatic after a predetermined elapsed operating time
20 at a particular state, for example an elapsed time
21 counter could be built into the apparatus to show a
22 warning signal when the predetermined operating time is
23 exceeded. The operator would then be alerted to switch
24 the apparatus to the next state.

25
26 Although the examples of Figs. 2 to 5 have been
27 described with reference to spot sources, it is to be
28 understood that the invention is equally applicable to
29 line focus sources. Furthermore the illustrated
30 embodiments have been described with a focussing means
31 which comprises a centring lens, a focussing lens and a
32 stigmator lens. It is to be understood that the
33 functions of any of the three lenses may be combined in
34 one or more lenses, and that the order of the
35 components of the focussing means may be varied.

36

1 Figs. 6(a) and 6(b) shows schematically a side view and
2 plan view respectively on a conventional sealed tube X-
3 ray generator. The generator comprises a sealed vacuum
4 enclosure 30 fabricated from glass and metal, or from
5 ceramic and metal. Inside the enclosure 30 is an
6 electron gun 31 and a target 32. Adjacent to the
7 target are X-ray transparent windows 33, through which
8 X-rays 36 are transmitted. Surrounding the vacuum
9 enclosure between the electron gun 31 and target 32 is
10 an electrostatic or electromagnetic lens. Behind the
11 target is a conventional water cooling arrangement 35.
12

13 The lens comprises one or more sets of focussing coils
14 34 arranged outside the vacuum envelope of the X-ray
15 tube 30. The coils 34 forming the lens may be
16 electromagnetic or electrostatic. At least one of the
17 sets of focussing coils 34 is used to steer the
18 electron beam from the electron gun 31 onto the target
19 32, and may also be used to change the shape and/or
20 size of the beam. A switch control (not shown) may be
21 provided which upon operation automatically provides
22 the electrical power to the coils 34 so as to steer the
23 electron beam to a larger focus or to a different point
24 on the target. This enables the power density loading
25 on the target 32 to be reduced when the X-rays are not
26 being used, or for new areas of the target 32 to be
27 periodically exposed when the previously exposed area
28 becomes damaged or degraded. In Fig. 6 the coils 34
29 are shown as being external to the vacuum. In this way
30 it is possible for the focussing coils 34 to be
31 retrofitted to an existing generator, in order to
32 prolong the life of the generator. However the scope
33 of the invention includes the case where the coils 34
34 are built in to the generator and provided inside the
35 vacuum enclosure 30.
36

1 Figs. 7(a) and 7(b) shows schematically a side view and
2 front view respectively on a conventional rotating
3 anode X-ray generator. The generator comprises a
4 continuously pumped vacuum chamber 40 containing an
5 electron gun 41 and a target 42 deposited on a
6 cylindrical anode 43 which rotates at high speed.
7 Adjacent to the anode are X-ray transparent windows 44,
8 through which X-rays 46 are transmitted. Surrounding
9 the vacuum chamber between the electron gun 41 and
10 target 42 is an electrostatic or electromagnetic lens.
11 The anode 43 is water cooled (not shown). The rotation
12 of the anode 43 dissipates more effectively the heat
13 generated on the target 42, so that increased power
14 loading of the target and hence increased X-ray
15 brightness are possible.

16
17 The electrostatic or electromagnetic lens comprises one
18 or more sets of focussing coils 45 arranged outside the
19 vacuum chamber 40. The coils 45 serve the same purpose
20 as the coils 34 described with reference to Fig. 6
21 above, and may also be retrofitted or fitted within the
22 vacuum chamber, ie the coils may be internal or
23 external.

24
25 These and other modifications and improvements can be
26 incorporated without departing from the scope of the
27 invention.
28

1 CLAIMS:

2
3 1. An X-ray generator comprising an electron gun,
4 electron focussing means, a target and electronic
5 control means, wherein the area of the target on
6 which the focussing means causes electrons from
7 said electron gun to impinge comprises an X-ray
8 source, the control means being adapted to control
9 the electron focussing means so that the X-ray
10 source on said target may be varied in size and/or
11 shape and/or position,

12 wherein the control means includes a
13 switching means to switch the electron focussing
14 means between a plurality of states, the X-ray
15 source on said target having a particular size
16 and/or shape and/or position in each of said
17 plurality of states.

18
19 2. An X-ray generator according to Claim 1, wherein
20 the control means includes a switching means to
21 switch the electron focussing means between a
22 first unfocussed state in which the X-ray source
23 has a first area and a second focussed state in
24 which the X-ray source has a second area smaller
25 than said first area.

26
27 3. An X-ray generator according to Claim 2, wherein
28 said first area has a surface area at least twice
29 that of said second area.

30
31 4. An X-ray generator according to either Claim 2 or
32 Claim 3, wherein said first area has a surface
33 area at least four times that of said second area.

34
35 5. An X-ray generator according to any of Claims 2 to
36 4, wherein said first area has a surface area at

1 least ten times that of said second area.

2

3 6. An X-ray generator according to Claim 1, wherein
4 the control means includes a switching means to
5 switch the electron focussing means between a
6 plurality of focussed states, whereby in each
7 state the X-ray source is in a corresponding
8 discrete position on said target.

9

10 7. An X-ray generator according to any preceding
11 claim, wherein the electron gun comprises an
12 evacuated tube, and wherein the electron focussing
13 means comprises an x-y deflection system for
14 centring the electron beam in the tube.

15

16 8. An X-ray generator according to any preceding
17 claim, wherein the electron beam focussing means
18 further comprises at least one electron lens.

19

20 9. An X-ray generator according to Claim 8, wherein
21 said electron lens comprises an axially symmetric
22 or round lens for focussing the electron beam to a
23 line focus and for steering the electron beam.

24

25 10. An X-ray generator according to Claim 8, wherein
26 said electron lens comprises at least one
27 quadrupole or multipole lens for focussing the
28 electron beam to a line focus and for steering the
29 electron beam.

30

31 11. An X-ray generator according to any preceding
32 claim, wherein the target is a metal selected from
33 the group Cu, Ag, Mo, Rh, Al, Ti, Cr, Co, Fe, W,
34 Au.

35

36 12. A method for extending the life of a target of an

1 X-ray generator, wherein the generator comprises
2 an electron gun, electron focussing means and a
3 target, the method comprising the steps of:

4 firing electrons at the target such that the
5 area of the target on which the focussing means
6 causes electrons from said electron gun to impinge
7 comprises an X-ray source,

8 controlling the electron focussing means to
9 move between a first unfocussed state in which the
10 X-ray source has a first area and a second
11 focussed state in which the X-ray source has a
12 second area smaller than said first area, the
13 intensity of electron impingement in the first
14 state being sufficiently low to reduce target
15 degradation, the intensity of electron impingement
16 in the second state being sufficiently high such
17 that the source produces a predetermined required
18 level of brightness and source size on the target.
19

20 13. A method according to Claim 12, wherein the
21 electron beam current is substantially the same in
22 the first and second states, while the intensity
23 of the beam per unit area at the target is lower
24 in the first state than in the second state.
25

26 14. A method for extending the life of a target of an
27 X-ray generator, wherein the generator comprises
28 an electron gun, electron focussing means and a
29 target, the method comprising the steps of:

30 firing electrons at the target such that the
31 area of the target on which the focussing means
32 causes electrons from said electron gun to impinge
33 comprises an X-ray source,

34 controlling the electron focussing means to
35 move between a plurality of focussed states,
36 whereby in each state the X-ray source is in a

1 corresponding discrete position on said target,
2 such that the intensity per unit area in each
3 discrete position is substantially constant, and
4 such that there is no overlap on the target
5 between the discrete positions corresponding to
6 each focussed state.

Fig. 1

2 / 3

Fig. 2

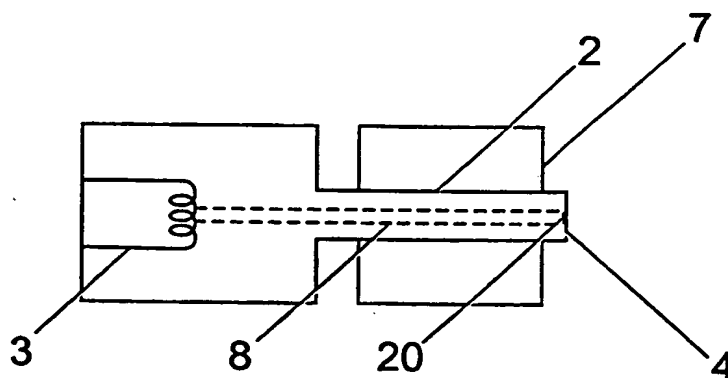


Fig. 3

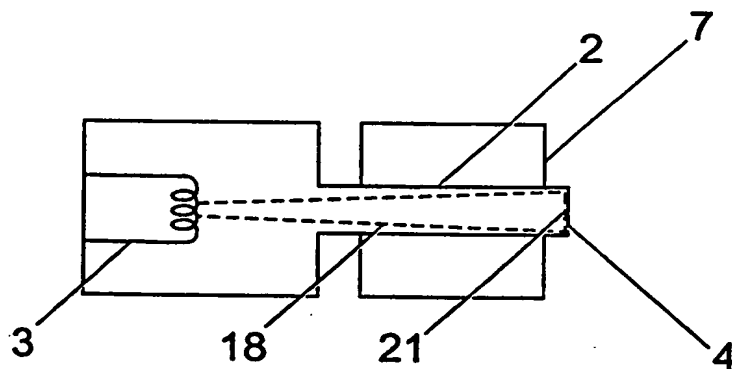


Fig. 4

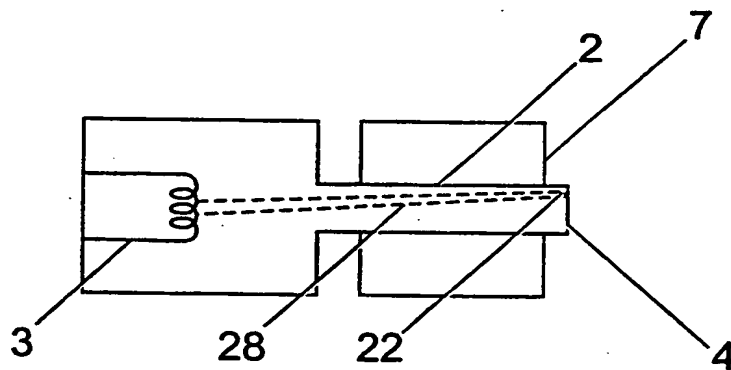
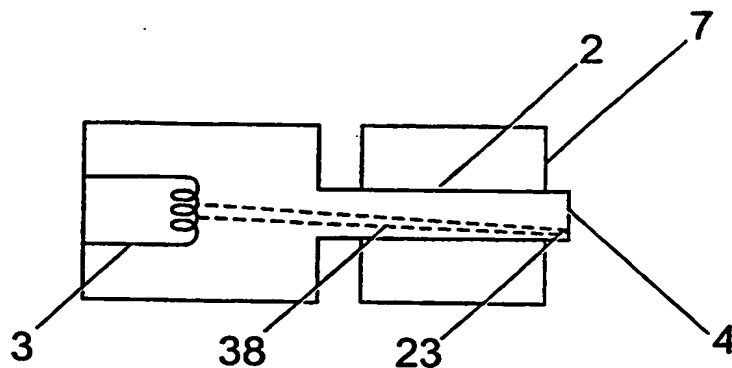


Fig. 5



3 / 3

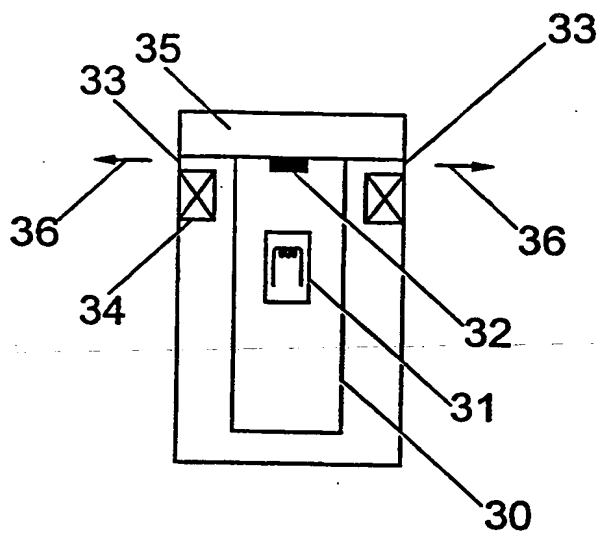


Fig. 6a

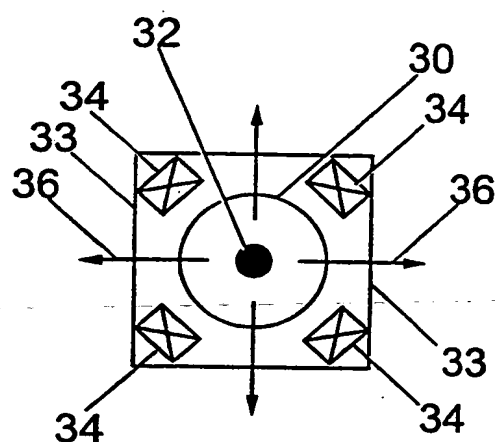


Fig. 6b

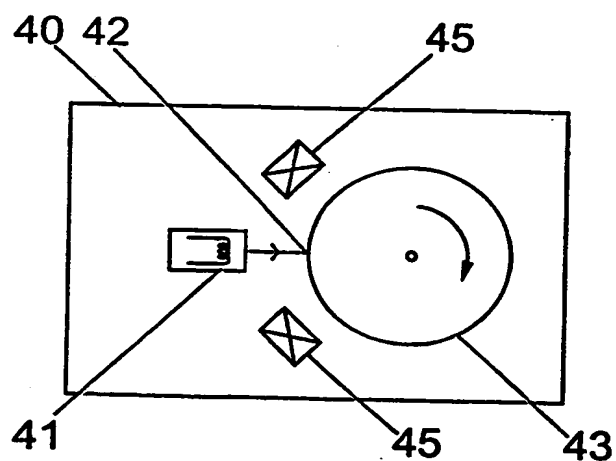


Fig. 7a

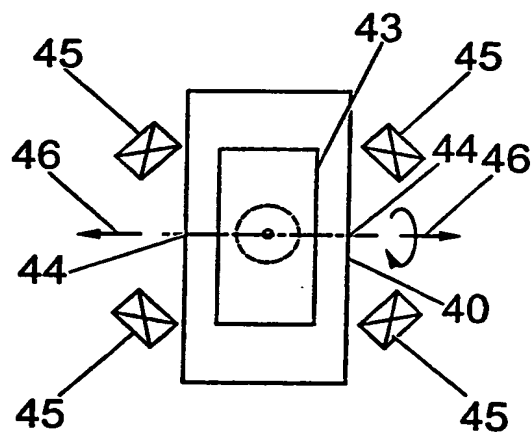


Fig. 7b

1 CLAIMS

2

3 1. An x-ray generator comprising an electron gun,
4 electron focusing means, a target and electronic
5 control means, wherein the area of the target on
6 which the focusing means causes electrons from said
7 electron gun to impinge comprises an x-ray source
8 emitting an x-ray beam, the control means being
9 adapted to control the electron focusing means so
10 that the x-ray source on said target may be varied
11 in size, wherein the x-ray generator further
12 comprises a shutter to control the emitted x-ray
13 beam, and wherein the control means includes a
14 switching means to switch the electron focusing
15 means between a first unfocused state in which the
16 x-ray source has a first area upon action of the
17 shutter and a second focused state in which the x-
18 ray source has a second area smaller than said first
19 area when the shutter is open.

20

21 2. An x-ray generator according to Claim 1,
22 wherein said first area has a surface area at least
23 twice that of said second area.

24

25 3. An x-ray generator according to Claim 1,
26 wherein said first area has a surface area at least
27 four times that of said second area.

28

29 4. An x-ray generator according to Claim 1,
30 wherein said first area has a surface area at least
31 ten times that of said second area.

32

1 5. An x-ray generator comprising an electron gun,
2 electron focusing means, a target and electronic
3 control means, wherein the area of the target on
4 which the focusing means causes electrons from said
5 electron gun to impinge comprises an x-ray source
6 generating an x-ray beam output, the control means
7 being adapted to control the electron focusing means
8 so that the x-ray source on said target may be
9 varied in size, wherein the control means includes a
10 switching means to switch the electron focusing
11 means between a plurality of focused states, whereby
12 in each state the x-ray source is in a corresponding
13 discrete stationary position on said target.

14
15 6. An x-ray generator according to any preceding
16 Claim, wherein the electron gun comprises an
17 evacuated tube, and wherein the electron focusing
18 means comprises an x-y deflection system for
19 centring the electron beam in the tube.

20
21 7. An x-ray generator according to any preceding
22 Claim, wherein the electron beam focusing means
23 further comprises at least one electron lens.

24
25 8. An x-ray generator according to Claim 7,
26 wherein said electronic lens comprises an axially
27 symmetric or round lens for focusing the electron
28 beam to a line focus and for steering the electron
29 beam.

30
31 9. An x-ray generator according to Claim 7,
32 wherein said electron lens comprises at least one

1 12. A method according to Claim 11, wherein the
2 electron beam current is substantially the same in
3 the first and second states, while the intensity of
4 the beam per unit area at the target is lower in the
5 first state than in the second state.
6

7 13. A method of extending the life of a target of
8 an x-ray generator, wherein the generator comprises
9 an electron gun, electron focusing means and a
10 target, the method comprising the steps of:

11 firing electrons at the target such that the
12 area of the target on which the focusing means
13 causes electrons from said electron gun to impinge
14 comprises an x-ray source, and

15 controlling the electron focusing means to move
16 between a plurality of focused states, whereby in
17 each state the x-ray source is in a corresponding
18 discrete stationary position on said target, such
19 that the intensity per unit area in each discrete
20 position is substantially constant, and such that
21 there is no overlap on the target between the
22 discrete positions corresponding to each focused
23 state.



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